

SECTION 02400
DRAINAGE AND SEWER SYSTEMS

PART 1 - GENERAL

0.1 DESCRIPTION OF WORK

- A.** Work Included: This Section specifies construction of drainage facilities and sanitary sewer facilities.
- B.** Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 02300 - EARTHWORK.
 - 2. Section 03300 - CAST-IN-PLACE CONCRETE.

0.2 SUBMITTALS

- A.** Shop Drawings. Include details of sewers and drains, including relationship to other systems; true position and details of interfaces, connections, inlets, cleanouts, manholes, alignment, grade, changes of direction, offsets, bedding, protection, materials and other pertinent data.

0.3 PRESSURE AND LEAKAGE TESTING AND TOLERANCES

- A.** Gravity Lines: Maximum allowable leakage for any section or sections, or for the total lengths of pipelines: 200 gallons per inch of diameter per mile per 24 hours.
- B.** Polyvinyl Chloride PVC:
 - 1. Testing of Pipe: After completing installation and backfill of pipe, the Contractor shall, at his expense, conduct a line acceptance test using low pressure air. Equipment used shall meet the following minimum requirements: Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected; Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking; All air used shall pass through a single control panel. Three individual hoses shall be used for the following connections: From control panel to pneumatic plugs for inflation; From control panel to sealed line for introducing the low pressure air; From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.
 - 2. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground

and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig (172.3689 Kpa). The sealed pipe shall be pressurized to 5 psig (34.47378 Kpa). The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

3. After a manhole to manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psig (172.4 Kpa). Low pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psig (27.579 Kpa) greater than the average back pressure of any groundwater that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize.
4. After the stabilization period (3.5 psig (24.1317 Kpa) minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed "Acceptable" if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (24.1317 to 17.2369 Kpa) (greater than the average back pressure of any groundwater that may be over the pipe) is not less than the time shown for the given diameter in the following table.

Pipe Diameter	Specification Time for Length Shown (min: sec)			
<u>Inches</u>	<u>100 ft.</u>	<u>200 ft.</u>	<u>300 ft.</u>	<u>400 ft.</u>
6	5:40	5:40	5:40	5:42
8	7:34	7:34	7:36	10:08
10	9:26	9:26	11:52	15:49
12	11:20	11:24	17:05	22:47
15	14:10	17:48	26:42	35:36
18	17:00	25:38	38:27	51:16
21	19:50	34:54	52:21	69:48
24	22:47	45:34	68:22	91:10

5. In areas where groundwater is known to exist, the Contractor shall install a 1/2 inch (1.27cm) diameter capped pipe nipple, approximately 10 inches long, through the manhole wall adjacent to one of the sewer lines entering the manhole. This shall be done at the time the line is installed. Immediately prior to the performance of the Line Acceptance Test, the groundwater shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the nipple. The hose shall be held vertically and a measurement of the height in feet of water over the invert of the pipe shall be taken after the water has stopped rising in this plastic tube. The height in

feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings. (For example, if the height of water is 11 1/2 feet, then the added pressure will be 5 psig. This increases the 3.5 psig to 8.5 psig, and the 2.5 psig to 7.5 psig. The allowable drop of one pound and the timing remain the same). In no case shall the starting pressure exceed 9.0 psig.

6. If the Contractor is unable to pass a pressure test because lines are "live", the Contractor shall perform closed circuit television inspections of the lines at no additional cost to the Authority. The Engineer must be able to witness the tests and must be provided with a video recording of each test for further inspection.
7. Test Failure: If the section of pipe fails to pass the leakage and pressure test, or if there is any visible leakage, the Contractor shall locate, uncover and repair or replace the defective pipe fitting or joint and retest all at his own expense. Pipe will be considered passing only when the leakage does not exceed the above standard. Passing the test does not absolve the Contractor from his responsibility if leaks develop later within the period of warranty.

C. RCP:

1. Leakage Tests: Leakage tests will be required by the Authority for all pipe and manhole installations. Tests shall meet all requirements of this paragraph. Leakage into or from the piping and structures, except storage tanks, will be determined respectively by infiltration tests or by exfiltration tests, as specified herein and as directed. The maximum allowable amount of infiltration into the piping or exfiltration from the piping as determined respectively by the infiltration tests or by the exfiltration tests, including manholes, shall be at a rate of not greater than 150 gallons (567.8l) per inch of pipe diameter per mile of pipe per 24 hours, and there shall be no gushing or spurting streams of water into or from the piping or manholes. The phrase, "per mile of pipe" shall refer to the total length of pipe measured through manholes. Where the groundwater level can be maintained at a height of not less than one foot (304.8 mm) above the top of the pipe for the full length of the section of pipe being tested for leakage, the leakage into the piping and manholes shall be determined as specified under "Infiltration Tests." Where the groundwater cannot be maintained at a level of not less than one foot (304.8 mm) above the top of the pipe for the full length of the section of pipe being tested, the leakage from the piping and manholes shall be determined as specified under "Exfiltration Tests". Perform all work, provide all necessary weirs or such other measuring devices as required, do all pumping and furnish all equipment necessary for the proper performance of leakage tests at no additional cost to the Authority. Leakage testing of piping shall be satisfactorily performed in sections as the work progresses, and as directed.
2. Infiltration Tests: The tests shall be conducted at such times as the groundwater level is at a height of not less than one foot (304.8 mm) above the top of the pipe for the full length of the section of the pipe

being tested. The groundwater leakage into the pipe will be measured by the Authority at such point or points as he may direct. Construct such weirs or other means of measurement as required and pump as necessary for the tests to be properly made.

3. Exfiltration Tests: Where exfiltration tests are required, the section of pipe to be tested shall be subjected to an internal pressure. The lower end of the section of pipe to be tested shall be closed and the entire section of the pipe, including manholes, shall be filled with clean water so as to obtain a minimum head of 2 feet (0.6096 m) above the top of the pipes; the length of the section of pipeline being tested shall be such that with the head of water 2 feet (0.6096 m) above the top of pipe at the upper end of the section of the pipeline being tested will not exceed 8 feet (2.4384 m). The rate of leakage from each section of the pipe being tested will be determined by the Authority by measuring the amount of water required to maintain the minimum head of 2 feet (0.6096 m) above the top of the pipe for the full length of each section of the pipes being tested.
4. Should the infiltration or exfiltration test on any section of the pipelines, including manholes, show a rate of leakage into or from the pipeline exceeding the maximum allowable rate of infiltration or exfiltration specified herein, locate, repair, or replace defective joints and work in a manner satisfactory to the Authority and retest at no additional cost to the Authority until the rate of infiltration into or exfiltration from each section of the pipeline being tested does not exceed the rate specified herein for infiltration or exfiltration.
5. The completed pipe and joints shall be visually inspected by the Engineer. If the Contractor is unable to pass a pressure test because lines are "live", the Contractor shall perform closed circuit television inspections of the lines at no additional cost to the Authority. The Engineer must be able to witness the tests and must be provided with a video recording of each test for further inspection.

D. Ductile Iron Force Mains:

1. Pressure Testing: All pipe and appurtenances installed shall be hydrostatically tested in accordance with ANSI/AWWA C600, latest version unless stated otherwise herein. Test pressure, expressed in terms of feet of water, applied at any point in pipe equals arithmetic difference between specified test pressure plane elevation and elevation of horizontal center line of pipe at selected location. Multiply value by 0.433 to obtain pounds per square inch. Ensure pressure gauges are accurately calibrated. Do not attempt pressure testing until all air has been vented from the mains. All new force mains that shall become the property of the Authority shall be pressure tested at a minimum of 150 psi for a continuous period of two hours.
2. Leakage Testing: Conduct leakage testing in conjunction with pressure tests. Ensure that joints in piping are watertight and free from visible leaks during leakage test.

3. Leakage Test Pressure: Maintain specified normal operating line pressure for pressure testing of reach during leakage test. Maintain hydrostatic pressure within plus or minus 5 percent during entire time of leakage measurements.
4. Leakage Measurement: Do not attempt measurement of leakage until trapped air has been vented and constant test pressure has been established. Measure leakage by means of an approved water meter installed in the pressure piping on discharge of the pump. Ensure that water meter is accurately calibrated.
5. Allowable Leakage: Ensure that pipe reach does not exceed the allowable leakage rate. Calculate allowable leakage with following formula:
 - a. $Q = 0.0075 \text{ DLN}$ where
 - b. Q = allowable leakage in gallons per hour
 - c. D = nominal diameter of pipe in inches
 - d. L = length of section tested in thousand feet (1000-foot maximum)
 - e. N = square root of avg test pressure in psi (12.25)
6. Calculate allowable leakage separately for each diameter and add resulting allowable leakage rates to obtain total allowable leakage for entire reach.

E. Drainage and Sanitary Structures and Catch Basins, Leakage Tests:

1. The manholes shall be made as nearly watertight as practicable.
2. The Contractor shall perform leakage tests on each manhole installed using an approved low air pressure testing system. This type of test shall be used only immediately after assembly of the manhole and only prior to backfilling. The manhole to pipe connection should only be a flexible connector. All lift holes shall be plugged with a non-shrinking mortar. For this test, each manhole shall be tested under 10-inch Hg vacuum. The test shall pass if the vacuum remains at 10-inch Hg or drops no lower than 9-inch Hg after 60 seconds for 4 or 5 foot manholes from 0 to 10 feet deep, 75 seconds for 4 or 5 foot manholes from 10 to 15 feet deep, or 90 seconds for 4 or 5 foot manholes from 15 to 25 feet deep. A volume equivalent shall be calculated for larger diameter manholes to determine the testing length based on these parameters.

PART 2 - PRODUCTS

0.1 GENERAL

- A.** Products used at interface with utility companies shall conform to the requirements of connected utility companies.

0.2 PIPE AND FITTINGS

A. Clay Pipe and Fittings

1. Pipe: ASTM C 700, except crushing strength shall be in accordance with National Clay Pipe Institute Specification ER4, salt or ceramic glazed, bell and spigot except where plain ends are indicated.
2. Joints and Gaskets: ASTM C 425.

B. Plain Concrete Pipe

1. Unperforated: ASTM C14, class as indicated, bell and spigot.
2. Perforated: ASTM C 444, type as indicated, and all applicable requirements of ASTM C 14, class as indicated.

C. Reinforced Concrete Pipe

1. Circular Section: ASTM C 76; ends, class, and wall as indicated.
2. Elliptical Section: ASTM C 507; ends and class as indicated.

D. Joints and Gaskets for Circular Concrete Pipe: ASTM C 443.

E. Cast Iron Culvert Pipe: ASTM A 142.

F. Corrugated Metal Pipe: AASHTO M 36, type and couplings as indicated, coated and paved per ASSHTO M 190, Type C coating and Type A coating for coupling bands.

G. Ductile Iron Pipe for Gravity and Force Mains:

1. Ductile iron pipe shall be that of a United States manufacturer who can demonstrate at least 5 years of successful experience in manufacturing ductile iron pipe. The pipe shall be equipped with push on type, restrained joint, or mechanical joints, as required.
2. All ductile iron pipe shall conform to ANSI/AWWA C 151/A21.51 and ASTM A 746.
3. The ductile iron pipe shall be, at a minimum, Class 52 or as determined considering the trench load and internal pressure separately in accordance with ANSI/AWWA C150/A21.50. Ductile iron pipe shall be H2 Sewer Safe Pipe (Sewper Coat lined).
4. The ductile iron pipe shall be asphalt coated on the outside and inside with a minimum of 1 mil bituminous paint according to ANSI/AWWA C151/A21.51 Section 51-8.1. Prior to the lining, the inside and outside of the spigot end shall be coated with a minimum of 8 mil of epoxy. The inside of the bell end including the gasket cavity shall also be coated with 8 mil of epoxy.
5. The ductile iron pipe lining shall be as manufactured by Lafarge Calcium Aluminates or approved equal. The coating shall be a calcium aluminate mortar consisting of calcium aluminate cement and fused calcium aluminate aggregates. A seal coat shall be applied to

the lining. The thickness of the lining shall be 0.125-in for 6-in through 12-in pipe and 0.1875-in for 14-in through 24-in pipe.

6. Gasket Materials: Push-on and mechanical joint gaskets shall be Nitrile (NBR) (Acrylonitrile Butadiene) or equal gasket acceptable for use in an environment which will handle fats, oils and greases unless otherwise noted or approved.
7. Fittings: Fittings shall be compact ductile iron Class 350 Mechanical Joint, conforming to ANSI Specification A21.53 (AWWA C 153), latest edition, for pipe sizes 16 inches and smaller, and Class 350 standard Mechanical Joint fittings conforming to AWWA C110/ANSI A21.10, latest edition except as specified, for pipe sizes 16 through 24 inches, unless specifically stated otherwise in the specifications or on the drawings. Fittings shall be suitable for use with restraints as specified hereinafter. Fittings shall be manufactured in the United States. Fittings shall be of the same material and have the same lining and coating as the pipe specified above. All fittings shall be marked with the weight and shall have distinctly cast upon them the pressure rating, the manufacturer's identification, nominal diameter of openings and the number of degrees or fraction of the circle on all bends.
 - a. Caps and plugs installed in all new work as indicated on the drawings shall be provided with a threaded corporation or bleeder valve so that air and water pressure can be relieved prior to future connection.
 - b. Solid sleeves shall be ductile iron with 350 psi rating. Sleeves shall conform to ANSI/AWWA C 110.

H. Polyvinyl Chloride Pipe:

1. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating or stiffness in psi (kpa).
2. The Contractor shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.
3. Pipe:
 - a. All PVC pipe shall be joined by compression joints unless otherwise shown or specified, and shall conform to the following requirements:
 - b. Non Perforated Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM D 3034, Class SDR 35. Material for PVC pipe shall conform to the requirements of ASTM D 1784 for Class 12454-B or 12454-C as defined therein. All diameters shall be as specified on the Contract Drawings.
 - c. Perforated PVC pipe shall conform to the requirements of ASTM D 3034, Class SDR 35. Material for perforated PVC pipe shall

conform to the requirements of ASTM D 1784 for Class 12454-B or 12454-C as defined therein. The pipe shall have 3/8 inch perforations, 6 inch on center and 4 holes per row. The pipe shall be 6 inch diameter unless otherwise specified on the Contract Drawings.

- d. Elastomeric seals for compression type joints for PVC pipe and fittings shall conform to the requirements of ASTM D 3212.
 - e. Service pipes for storm services shall be minimum of 8-inches and shall match diameter of existing services for reconnections. Service pipes for sanitary services shall be minimum of 6-inches and shall match diameter of existing, services for reconnections.
4. Fittings:
- a. All fittings shall conform to the requirements of ASTM D 3034 or ASTM F 679. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.
 - b. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.
 - c. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.
5. Connections:
- a. Sanitary services shall be connected to new, parallel or replacement sanitary sewer lines with full bodied tees or wye fittings.
 - b. Storm services shall be connected to new, parallel, or replacement storm sewer lines with full bodied tees or wye fittings for all pipes up to 18-inches in diameter. Connections to pipes larger than 18-inches in diameter or odd sizes shall be made with saddle tap connections, as approved by Engineer.
 - c. Connections of storm and sanitary service lines to existing storm and sanitary main lines shall be made with full bodied tees or wye fittings wherever possible for existing lines less than 18-inches in diameter and with tapping saddles as approved by Engineer for existing lines greater than 18-inches in diameter and in odd sizes.
6. Gaskets: Flexible elastomeric rings conforming with ASTM F 477.

I. Solid Wall High Density Polyethylene Pipe (HDPE):

- 1. The HDPE replacement pipe shall be manufactured from a high density, high molecular weight polyethylene resin, which conforms to ASTM D-1248 and meets the requirements for Type III, Class B, Grade P34, Category 5, and has a PPI rating of PE 3408, when compounded. The pipe produced from this resin shall have a minimum cell classification of 345434C or D under ASTM D 3350.

2. The wall thickness of the HDPE pipe shall be as determined by the Contractor for the minimum thickness required to meet the structural requirements listed under Design Criteria below, and shall meet the following:
3. Minimum Wall Thickness: 0-12 feet depth, minimum wall thickness SDR 26; over 12 feet depth, SDR 21 minimum wall thickness.
4. All pipe shall be made of virgin material. No re-work, except that obtained from the manufacturer's own production of the same formulation shall be used.
5. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
6. The interior surface of the HDPE pipe shall not be dark or non-reflective in nature that could inhibit proper television inspection.
7. The finished HDPE pipe shall be continuous over the entire length of an insertion run between the insertion pit and reception pit. The HDPE pipe shall be impervious and free of any leakage from the rehabilitated host pipe to surrounding ground, or from the surrounding ground to the inside of the pipe.
8. The manufacturer of the pipe shall supply the AUTHORITY with certificates of compliance indicating conformance for all material and testing requirements furnished under these Specifications.
9. Each standard pipe unit shall be clearly and permanently marked with the date of manufacture, class, production code, and manufacturer's trademark.
10. The Contractor and manufacturer shall exercise extreme care during transportation, handling, storing, and installation of the HDPE pipe to ensure that the pipe is not gouged or otherwise damaged in any way. The Contractor shall store the pipe with a cover to block ultraviolet light in accordance with the manufacturer's recommendations. If the HDPE pipe becomes gouged or otherwise damaged, before or during installation, it shall be replaced or repaired by the Contractor at no additional cost to the Authority.

J. Centrifugally Cast Fiberglass Reinforced Pipe (FRP):

1. General: Workmanship and methods shall be in accordance with the best practices of modern shops for this type of work and shall be the product of a manufacturing firm having at least five years experience in the manufacture of this type of pipe. Pipe shall have a smooth and even interior surface free from roughness or irregularities. Prior to fabrication of pipe, submit shop drawings showing lengths of pipe, pipe joint details, construction details and tolerances as required by the Authority. Each pipe shall be marked with the date of manufacture, mark or trademark of the manufacturer, and the class, wall thickness of the pipe, and serial number. No slurry mix shall be used on interior of pipe.
2. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a

- composite material of similar construction and composition as the proposed product.
3. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.
 4. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.
 5. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product.
 6. Elastomeric Gaskets: Gaskets shall be supplied by qualified gasket manufacturers and be suitable for the service intended.
 7. Pipes, Joints, and Fittings:
 - a. Pipe shall be manufactured by the centrifugal casting process to result in a dense, nonporous, corrosion-resistant, consistent composite structure.
 - b. Actual outside diameter (18" to 48") of the pipes shall be in accordance with ASTM D 3262. For other diameters, OD's shall be per manufacturer's literature.
 - c. Minimum wall thickness shall be the stated design thickness.
 - d. Pipe ends shall be square to the pipe axis with a maximum tolerance of 1/8".
 8. Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings or bell-spigot joints, "flush" or "non-flush", that utilize elastomeric sealing gaskets as the sole means to maintain joint watertightness. The joints must meet the performance requirements of ASTM D 4161. Joints at tie-ins, when needed, may utilize fiberglass, gaskets-sealed closure couplings.
 9. Flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy-coated steel and stainless steel fittings may also be used.

0.3 STRUCTURAL STEEL FOR SITE ERECTION

- A. Corrugated: AASHTO M 167.
- B. Flat: AASHTO M 218.

0.4 UNDERDRAIN FILTER

- A. Pervious Backfill: Section 02300 - EARTHWORK.

0.5 DRAINAGE AND SANITARY STRUCTURES

- A.** Precast Manhole and Catch Basin Sections: ASTM C 478.
- B.** Precast Sections (for non-load bearing drainage structures other than manholes): ASTM C 139.

0.6 BRICK

- A.** ASTM C32, Grade SS, 2-1/4 inches by 3-3/4 inches by 8 inches.

0.7 CONCRETE

- A.** Concrete, General: Section 03300 - CAST-IN-PLACE CONCRETE.
- B.** Cradles and Cradle-Arches: Class 4,000-3/4.
- C.** Manholes and Other Load-Bearing Drainage Structures: Class 4000-3/4.

0.8 CEMENT MORTAR

- A.** One part Portland cement, two parts sand by volume with sufficient water to form a workable mixture, mortar minimum strength of 3,000 psi.

0.9 FRAMES AND COVERS

- A.** Frames and covers shall be heavy-duty Type A Massachusetts Standard and conform to the "Standard Specifications for Highways and Bridges", of the Commonwealth of Massachusetts. All frames shall have a minimum clear opening of 30 inches unless otherwise noted.
- B.** Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow-holes and other defects affecting the strength and value for the service intended. The finished coating shall be tough and tenacious when cold and not brittle or with any tendency to scale off under seasonable temperature changes.
- C.** Frames and Covers shall be Cast Iron, minimum Class 25 conforming to ASTM A 48, and as follows: Castings to be free from scale, lumps, blisters and sandholes. Machine contact surfaces to prevent rocking. Thoroughly clean and hammer inspect.
- D.** Frames and covers to be as manufactured by E. L. LeBaron Foundry Co., Neenah Foundry Co., Campbell Foundry Company or equal. Frames and covers shall be capable of withstanding AASHTO H-20 loading unless otherwise indicated or specified.

- E. The Contractor shall furnish all manhole frames and covers conforming to the details shown on the drawings, or as herein specified. Frames and covers shall be of cast iron with diamond cover surface design. Manhole covers shall be machined to fit securely and evenly on the frame.
- F. Covers for all structures shall have the word "DRAIN", "SEWER" or other appropriate designation cast upon them.

0.10 FRAMES

- A. Single Catch Basin Frames shall be as manufactured by E. L. LeBaron Foundry Co., model LK120D for three flange, Neenah Foundry Co., Campbell Foundry Co., or equal.
- B. Double Catch Basin Frames shall be as manufactured by E. L. LeBaron Foundry Co., model LV2448-2 with longside flange removed, Neenah Foundry Co., Campbell Foundry Co., or equal.

0.11 GRATES

- A. Single and Double Catch Basin Grates shall be cascade type, as manufactured by E. L. LeBaron Foundry Co., model L24SG18, by Neenah Foundry Co., by Campbell Foundry Co., or equal unless otherwise shown on the Drawings.

0.12 HOODS

- A. Catch Basin Hoods shall be as manufactured by E. L. LeBaron Foundry Co., model L-202, Neenah Foundry Co., Campbell Foundry Co., or equal.

0.13 NO DUMP CURB MARKERS

- A. No-dump markers shall be installed on all existing-to-remain or proposed catch basins and inlets within the project area. Curb markers shall be 4" diameter, 0.090 mil. thick, PVC laminate, with urethane dome, as manufactured by Das Manufacturing Inc., Duracast style.

0.14 FLEXIBLE MANHOLE SEALS

- A. Flexible manhole seals shall be "New Lok Joint Flexible Sleeve" by Interpace, "A-Lok Manhole Sleeve" by L & L Concrete Products, "Press Wedge II" by Pre-Seal Basket Corporation, or approved equal. Field applied seals shall be "K or N Seal" boot or equal. Manhole sleeves, gaskets and sealants shall be furnished complete with lubricants, stainless steel stops, inserts, clamps, etc.

PART 3 - EXECUTION

0.1 GENERAL

- A.** Excavation. Excavate trenches as specified in Section 02300 - EARTHWORK.
- B.** Bedding. Classes of bedding are defined in ASTM C12. Use class of bedding indicated; prepare trench and bedding as specified in ASTM C12. Place concrete for encasement against undisturbed soil.
- C.** Pipe Laying. Lay all pipe in accordance with the manufacturer's written instructions. Additional requirements for specific types of pipe are included in subsequent articles herein.
- D.** Structures. Construct manholes, junction chambers, inlets, wingwalls, and other related drainage structures in connection with the installation of pipe. Install or cut pipe flush with the inside face of structure walls.
- E.** Protection
 - 1. Protect joint materials from the air and sun to prevent drying and other deterioration.
 - 2. Take precautions to prevent flooding of trench prior to backfilling.
 - 3. Do not allow free water to come in contact with pipelines until Portland cement joint and sealing materials have set for at least 24 hours.
- F.** Backfill. Backfill trenches as specified in Section 02300 - EARTHWORK.

0.2 CRADLES

- A.** Where gravel, crushed stone, or concrete cradles are indicated, provide bell holes in subgrade to permit uniform cradle depth beneath entire pipe length.

0.3 JACKING PIPE

- A.** At locations indicated jack reinforced concrete pipe, steel casing pipe, fiberglass reinforced pipe or corrugated metal pipe into place between limits indicated.
- B.** Strength, reinforcement, and gauge of pipe designated to be jacked will be determined for vertical loads only. Provide additional reinforcement or higher strength or heavier gauge pipe as necessary to withstand jacking pressure, at no additional expense to the Authority.

- C. Excavate for jacking pipe not more than 0.1 foot wider than outside limits of pipe. When material tends to cave beyond that limit, use a shield ahead of the first section of pipe. Backfill caving and excavation beyond that limit with sand or grout to fill voids.
- D. Sluicing and jetting will not be permitted.

0.4 INSTALLATION OF CORRUGATED METAL PIPE

- A. Distortion: When circular pipe 48 inches in diameter and larger is to be placed under fills, distort the pipe for its full length before placing backfill. When specified, distort smaller circular pipe.
 - 1. Distort pipe from a true circle to increase the vertical diameter by approximately three percent through the full length.
 - 2. Pipe may be distorted either in the shop or in the field. If pipe is to be distorted in the field, use one of the following methods:
 - a. By mechanical pressure sufficient to introduce a permanent distortion in pipe; or
 - b. By distorting assembled pipe and retaining distortion by means of rods, wires, struts, or other means.
- B. Placement: Lay distorted circular pipe with major axis vertical. Maintain rods, wires, struts, or other means used to maintain distortion in place until completion of backfill or embankment, but remove prior to construction of headwalls and other structures at ends of pipe.
- C. Joining: Join sections of pipe with corrugated metal bands. Do not damage protective coating when tightening bolts. After final tightening, apply brush coat of bituminous paint to bands and bolts.

0.5 INSTALLATION OF REINFORCED CONCRETE PIPE

- A. Placement: Lay pipe upgrade with bell or groove end uphill. Place circular pipe having elliptical reinforcement with minor axis of the reinforcement in vertical position.
- B. Backfilling: Except where an exfiltration/infiltration test is to be performed, backfill of culvert-pipe and siphon-pipe trenches may be completed while joint mortar is still plastic. Should joint mortar become set before placing backfill, do not commence backfilling within 16 hours of joining pipe sections.

0.6 INSTALLATION OF DUCTILE IRON PIPE

- A. Handling Pipe: The Contractor shall take care not to damage pipe by impact, bending, compression, or abrasion during handling, and

installation. Joint ends of pipe especially shall be kept clean. Pipe shall be stored above ground at a height no greater than 5 feet, and with even support for the pipe barrel. Only nylon protected slings shall be used for handling the pipe. No hooks or bare cables will be permitted. Gaskets shall be shipped in cartons and stored in a clean area, away from grease, oil, heat, direct sunlight and ozone producing electric motors.

- B.** Alignment and Placement of Pipe: Jointing of ductile iron pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The last 8 inches of the outside of the spigot end of pipe and the inside of the bell end of pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to insure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.
- C.** Installation and jointing of push-on ductile iron pipe shall be in accordance with AWWA C 600 Sections 9b and 9c, latest revision, as applicable. Mechanical joints shall be installed with Mega-Lug, Uni-Flange or MJR restraints. Restraints shall be installed in full accordance with the manufacturers' instructions. All bolt heads on Mega-Lugs or Uni-flanged shall be tightened sufficiently so that they shear off to provide indication that proper tightening torque was achieved. MJR systems shall be installed with ductile iron locking ring, tapered MJ gland and a symmetrical locking ring. Restrained push on joints shall be installed with specified gasket joint restraints. Restraints shall be installed in full accordance with the manufacturers' instructions. Fittings and valves shall be restrained as shown on the drawings.
- D.** Piping Support: Furnish and install supports to hold piping at lines and grades indicated or specified. Support pipe and appurtenances connected to equipment to prevent any strain imposed on equipment.
- E.** Pipe and Fittings: Remove and replace defective pieces. Clear of all debris and dirt before installing and keep clean until accepted. Lay accurately to lines and grades indicated or required. Provide accurate alignment, both horizontally and vertically. Provide firm bearing along entire length of buried pipelines.
- F.** Appurtenances: Set valves, fittings and appurtenances as indicated.
- G.** Push-on Joints: Insert gasket into groove bell. Apply thin film of nontoxic gasket lubricant over inner surface of gasket in contact with spigot end. Insert chamfered end into gasket. Force pipe past it until it seats against socket bottom. Where required install restraint and secure in accordance with manufacturer's instructions.

- H.** Mechanical Joints: Wire brush surfaces in contact with gasket and clean gasket. Lubricate gasket, bell, and spigot with soapy water. Slip gland and gasket over spigot, and insert spigot into bell until seated. Seat gasket and press gland firmly against gasket. After bolts inserted and nuts made finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint by torque wrench. Torque bolts to values specified above.
- I.** Testing: Clean of all dirt, dust, oil, grease and other foreign material, before conducting pressure and leakage tests.

0.7 INSTALLATION OF PVC PIPE

- A.** Each pipe unit shall be inspected before being installed. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16 inch per foot of length. If a piece of pipe fails to meet this requirement for straightness, it shall be rejected and removed from the site. Any pipe unit or fitting discovered to be defective, either before or after installation, shall be removed and replaced with a sound unit.
- B.** No pipe or fitting shall be permanently supported on saddles, blocking, or stones. Crushed stone shall be as specified in Section 02300 - EARTHWORK.
- C.** Suitable bell holes shall be provided, so that after placement, only the barrel of the pipe receives bearing pressure from the supporting material. Special care shall be taken to hold the trench width at the crown of the pipe to the maximum indicated on the Trench Detail included in the Details Section of these specifications.
- D.** All pipe and fittings shall be cleared of all debris, dirt, etc., before being installed and shall be kept clean until accepted in the completed work.
- E.** Pipe and fittings shall be installed to the lines and grades indicated on the Drawings. Care shall be taken to ensure true alignments and gradients.
- F.** Before any joint is made, the previously installed unit shall be checked to assure that a close joint with the adjoining unit has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to the required grade by striking it with a shovel handle, timber or other unyielding object.
- G.** All joint surfaces shall be cleaned. Immediately before jointing the pipe, the bell or groove shall be checked to see that the rubber ring is properly seated. Apply lubricant to the spigot end only, paying particular attention to the bevel, in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. Suitable devices shall be used to force the pipe units

together so that they will fit with minimum open recess inside and outside and have tightly sealed joints. Care shall be taken not to use such force as to wedge apart and split the bell or groove ends. Joints shall not be "pulled" or "cramped" unless permitted by the Engineer.

- H.** Where any two pipe units do not fit each other closely enough to enable them to be properly jointed, they shall be removed and replaced with suitable units and new gaskets.
- I.** Details of gasket installation and joint assembly shall follow the directions of the manufacturers of the joint materials and of the pipe, all subject to review by the Engineer. The resulting joints shall be watertight and flexible.
- J.** All premolded gasket joint polyvinyl chloride pipe of a particular manufacturer may be rejected if there are more than five unsatisfactory joint assembly operations or "bell breaks" in 100 consecutive joints, even though the pipe and joint conform to the appropriate ASTM Specifications as hereinbefore specified. If the pipe is unsatisfactory, as determined above, the Contractor shall, if required, remove all pipe of that manufacturer of the same shipment from the work and shall furnish pipe from another manufacturer which will conform to all of the requirements of these specifications.
- K.** Open ends of pipe and branches shall be closed with polyvinyl chloride stoppers secured in place in an acceptable manner.
- L.** After each pipe has been properly bedded, enough crushed stone shall be placed between the pipe and the sides of the trench, and thoroughly compacted, to hold the pipe in correct alignment. Bell holes, provided for jointing, shall be filled with crushed stone and compacted, and then crushed stone shall be placed and compacted to complete the pipe bedding.
- M.** The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench. At all times pipe installation is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs, or by other acceptable means.
- N.** If water is in the trench when work is to be resumed, the plug shall not be removed until suitable provisions have been made to prevent water, earth, or other substances from entering the pipe. Pipelines shall not be used as conductors for trench drainage during construction. Install PVC pipe and fittings in accordance with manufacturer's printed instructions.
- O.** Allowable Pipe Deflection: Pipe provided under this Specification shall be so installed as to not exceed a maximum deflection of 5.0 percent. Such deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe. Upon completion of a section of pipe, including placement and compaction of backfill, the Contractor

shall measure the amount of deflection by pulling a specially designed gage assembly through the completed section. The gage assembly shall be in accordance with the recommendations of the pipe manufacturer, and be reviewed by the Engineer. The section of pipe must be placed and backfilled for a minimum of 90 days before the deflection can be measured. Should the installed pipe fail to meet this requirement, the Contractor shall do all work to correct the problem without additional compensation.

- P.** Cleaning: Care shall be taken to prevent earth, water and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes being careful to prevent soil, water and debris from entering any existing pipe.

0.8 INSTALLATION OF FRP PIPE

- A.** General: Installation of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's requirements. In addition, installation of piping shall be in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
- B.** Handling Pipe: Textile slings, other suitable materials or a forklift shall be used in the handling of pipes. Use of chains or cables is not recommended. Each pipe unit shall be handled into its position in the trench only in such manner and by such means, as the Engineer accepts as satisfactory. The Contractor will be required to furnish suitable devices to permit satisfactory support of all parts of the pipe unit when it is lifted.
- C.** Laying Pipe: Except where a concrete cradle or envelope is required, all pipe shall be laid in crushed stone. In trenches, no blocking or supporting of the piping by concrete, stones, bricks, wooden wedges, or method other than bedding the pipe on crushed stone will be permitted. Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.
- D.** Jointing Pipe: After the pipe are aligned in the trench and are ready to be jointed, the following shall be performed: Ends of pipe and coupling components shall be cleaned. Joint lubricant shall be applied to pipe ends or bell interior surfaces and the elastomeric seals. Only lubricants approved by the pipe manufacturer shall be used. Suitable equipment and end protection to push or pull the pipes together shall be used. Recommended forces by the manufacturer for joining or pushing pipe shall not be exceeded. Pipes shall be joined in straight alignment and then deflected to required angle. Deflection angle shall not exceed the deflection permitted by the manufacturer.
- E.** Alignment and Placement: All pipe shall be laid with extreme care as to grade and alignment. Each pipe shall be so laid as to form a close joint

with the next adjoining pipe and bring the inverts continuously to the required grade.

- F. Cleaning: Care shall be taken to prevent earth, water and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes being careful to prevent soil, water and debris from entering any existing Drain. Place plugs in end of uncompleted conduit at end of day or whenever work stops. Flush lines between manholes if required to remove collected debris.

0.9 CONCRETE ENCASEMENT

- A. If pipe is indicated to be entirely or partly embedded in concrete, support and brace pipe in a manner that will prevent movement or displacement of pipe during testing and during placement and consolidation of concrete.
- B. Place concrete as specified in Section 03300 - CAST-IN-PLACE CONCRETE, being careful to tamp concrete under and around pipe without displacing pipe.
- C. Do not use earth form.

0.10 BACKFILL

- A. Partial Backfill Before Testing
 - 1. Deposit and compact backfill in four inch layers around bottom half of pipe and for full width of trench, leaving top half of pipe exposed.
 - 2. Deposit and compact additional backfill between joints, to a depth of 12 inches above top of pipe, leaving joints exposed.
- B. Final Backfill After Testing
 - 1. Backfill and compact as specified in Section 02300 - EARTHWORK, flush with finished grade. If permitted by the Engineer, surface of backfill may be slightly convex.
 - 2. Restore surface to its original condition or as required.

0.11 LEAKAGE TOLERANCES

- A. Gravity Lines. Maximum allowable leakage for any section or sections, or for the total lengths of pipe lines: 200 gallons per inch of diameter per mile per 24 hours.
- B. Force Mains: Zero leakage in 30 minutes at 150 percent of the maximum pressure that pump or ejector is capable of developing.

PART 4 - MEASUREMENT AND PAYMENT

0.1 MEASUREMENT

- A.** Pipe will be measured by the linear foot for each type and size, along the center line with deduction made for manholes, inlets or other drainage structures measured from the inside face of each structure.
- B.** Drainage and sanitary sewer structures will be measured per each type and size built.
- C.** Items including: pipe fittings, joints, excavation, protective coatings, manhole steps, 6-inch drainage connection stubs through drainage structures, collar taps and cutting of pipes, manholes and inlet bases will not be separately measured and all costs in connection therewith will be considered incidental to the item of work to which they pertain.
- D.** Concrete for encasement shall be measured in accordance with Section 03300 - CAST-IN-PLACE CONCRETE.
- E.** Catch Basin Type 'A' shall be measured per each Boston Water and Sewer Manhole Type No. 5 installed. Catch Basin Type 'B' shall be measured per each Boston Water Manhole Type No. 13 installed.
- F.** Catch Basins or Manholes Removed and Utility Structures Adjusted shall be measured in accordance with Section 02650 - EXISTING SITE UTILITIES.
- G.** Allowances for Boston Water and Sewer Commission inspection services shall be measured in accordance with Section 01020 - ALLOWANCES.
- H.** Drainage Structure Rebuilt shall be measured per vertical foot of structure designated to be rebuilt on the drawings. Measurement shall also include structures which, in the course of construction are identified by the Engineer as having deteriorated beyond acceptable limits and must be rebuilt.
- I.** Catch Basin or Manhole Change in Type shall be measured for each catch basin converted to a manhole or vice versa.
- J.** Frames and Grates or Covers Municipal Standard shall be measured per each grate or cover installed. Frames and Grates or Covers Remove and Reset shall be measured per each frame and grate or cover reset.
- K.** Relocate Sanitary Sewer Manhole shall be measure per each manhole relocated.
- L.** Excavation, backfill, gravel and sand borrow shall be measured in accordance with Section 02300 - EARTHWORK.

0.2 PAYMENT

- A.** Reinforced Concrete Pipe shall be paid for at the Contract unit price per linear foot of pipe installed by size. Ductile iron pipe shall be paid for at the Contract Unit price per linear foot for drainage and sewerage of pipe installed by size. 8 inch ductile iron pipe shall be paid for at the Contract Unit Price per linear foot of cast iron drainage pipe installed. Payment shall be full compensation for all labor, materials and equipment required to install pipes in the sizes and types indicated on the Contract Documents.
- B.** Drop Inlets shall be paid for at the Contract unit price per each drop inlet installed complete in place. Payment shall be full compensation for all labor, materials and equipment required to install drop inlets at locations shown on the Contract Documents.
- C.** Catch basins shall be paid for at the Contract unit price per each catch basin installed by type. Payment shall be full compensation for all labor, materials and equipment required to install BWSC manholes. Payment shall include but not be limited to hoods where required, concrete collars, flexible rubber collars, masonry and mortar as required to adjust frame to grade, steps and ladders and the pre-cast manhole structure.
- D.** Sanitary Sewer Manhole shall be paid for at the Contract unit price per each installed complete in place. Payment shall be full compensation for all labor, materials and equipment required to install sanitary sewer manholes. Payment shall include but not be limited to the concrete collars, flexible rubber collars, masonry and mortar as required to adjust frame to grade, steps and ladders and the pre-cast manhole structure.
- E.** Gasoline and Oil Water Separator Manholes shall be paid for at the Contract unit price for each oil water separator manhole or Catch Basin with an Oil Trap outlet installed. Payment shall be full compensation for all labor, materials and equipment required to install oil water separator manholes at location shown on the Contract Documents. Payment shall include but not be limited to oil trap outlets, concrete collars, flexible rubber collars, masonry and mortar as required to adjust frame to grade, steps and ladders and the pre-cast manhole structure.
- F.** Relocate Sanitary Sewer Manhole shall be paid for at the Contract unit price for each sanitary sewer manhole relocated. Payment shall be full compensation for all labor, materials and equipment required to relocate existing sanitary sewer manholes as shown on the Contract Documents.
- G.** Frame and Grate or Cover Municipal Standard and Frames and Grates or Covers Remove and Reset shall be paid for at the Contract unit price per each. Payment shall be full compensation for all labor, materials and equipment required to install new frames and grates or covers; or remove and relocate existing frames and grates or covers at location shown on the Contract Documents.

- H.** Catch Basins or Manholes Removed shall be paid for in accordance with Section 02650 - EXISTING SITE UTILITIES.
- I.** Drainage Structure Rebuilt shall be paid for at the Contract unit price per vertical foot of structure rebuilt. Payment shall be full compensation for all labor, materials and equipment required to rebuild structures. Payment for this item of Work includes any and all interim adjustments to the structure required for construction staging.
- J.** Catch Basin or Manhole Change in Type shall be paid for at the Contract unit price per each manhole converted to a catch basin or vice versa. Payment shall be full compensation for all labor materials and equipment required to modify existing catch basins or manholes.
- K.** Payment for Boston Water and Sewer Commission services will be made as specified in Section 01020 - ALLOWANCES.
- L.** Plumbing System shall be paid for at the Contract lump sum for the design of the proposed sewer connection for the Green Line station. Payment shall be full compensation for all labor, equipment and materials required to design and coordinate with the BWSC and the Engineer to develop a final design for sewer service to the Green Line Station.

0.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0222.528	RELOCATE SANITARY SEWER MANHOLE	EA
0222.530	CATCH BASIN IN MANHOLE CHANGE IN TYPE	EA
0222.542	FRAMES AND GRATES OR COVERS REMOVE AND RESET	EA
0250.094	CATCH BASIN TYPE A	EA
0250.095	CATCH BASIN TYPE B	EA
0251.768	6" DUCTILE IRON PIPE	EA
0251.770	8" DUCTILE IRON PIPE	LF
0215.768	18" DUCTILE IRON PIPE	EA
0255.077	FRAME AND GRATE OR COVER MUNICIPAL STANDARD	EA
0255.196	SANITARY SEWER MANHOLE ECC MUNICIPAL STANDARD	EA

0255.088	DROP INLET	EA
0222.522	PRECAST DRAIN MANHOLE	EA
0255.200	SANITARY SEWER MANHOLE	EA
0255.604	DRAINAGE STRUCTURE REBUILT	VF
0348.412	12" REINFORCED CONCRETE PIPE CLASS IV	LF
0348.415	15" REINFORCED CONCRETE PIPE CLASS IV	LF
1460.200	GASOLINE AND OIL SEPARATOR MANHOLE	EA
1502.010	PLUMBING SYSTEM	LS

END OF SECTION

NOTES TO THE DESIGNER

- A.** Any request to modify or waive the specification requirements listed below must be approved in writing by the MBTA's Director of Design:

1. None